Research on the Trigger Design Inspiration by Biomimetic Product Patents

Hui ZHANG
School of Naval Architecture and Ocean Engineering, Zhejiang Ocean University, Zhoushan, Zhejiang, China

Keywords: Inspirations, Innovation design, Biomimetic product patents, Semantic associated expansion.

Abstract. Inspiration is an important way to stimulate product innovation design. To trigger the inspiration of creative design for designers, a new method of triggering design inspiration by biomimetic product patents is presented. First, a particularly useful and efficient method, namely method of semantic associated expansion, is presented to obtain associated biomimetic product patents. Then the method of recognition and extracting inspiration factor from obtained biomimetic product patents is proposed, the process model is established to stimulate design inspiration. Finally, the proposed methods and models are practiced by the creative design of the underwater diamond wire saw machine. The experimental results show that the proposed method is effective.

Introduction

As a result of inspiration trigged, the patent literature is a kind of technical documentation in novelty, inventiveness and usefulness. It contains the latest research results in the field, has become a new source of knowledge to trigger designer inspiration. Especially for biomimetic product patents, namely patents of using the novel biological functions, principles or structure, contain more new principles, new functions and new structures to trigger inspiration.

Inspiration is the result of an illogical. It is an instant burst of creative breakthrough of thinking under the stimulus of the outside information and is the result of the conscious and subconscious interactions and mutual accommodation [1]. It is the knowledge from outside the problem domain in the form of a set of decision rules [2]. In terms of features of inspiration, inspiration not only is random, instantaneous and trigger, but also lured outside, unexpected and lag. It has a sudden inspiration thinking, randomness, excitement and jump [3]. In the field of inspirations stimulating, the dual-threshold hypothesis of neural activity is proposed in the [4]. In the field of inspirations stimulating factors, the inspiration can be triggered by the function, color and shape information in the nature [5]. The photos, images, clothing, arts and crafts, samples, antiques, as well as the beauty of nature can be presented inspirational resource [6]. The apparel, fashion photos, crafts, and nature pictures, stories, etc., also are inspirational resources [7]. It can be seen from the literature that inspiration is the result of interaction between information and internal demand. It takes many forms and sudden, transient and trigger features. It can be stimulated through a variety of external information for product design. However, how to use biomimetic patents to trigger design inspiration and innovative design is not researched.

In recent years, the research has made some progress in inspired product innovation. The inspiration became an important way to stimulate product innovation [8,9]. The researches on artificial inspiration are a few. YEN and DONG proposed that the language resources including designing notes and design documentation were based on design information and used to trigger inspiration [10,11]. TRIZ is an innovative method used to trigger the process of problem solving in the [12]. The solutions were obtained through analyzing patent document, editing technical knowledge and identifying project conflicts. The difficulty lies in the need to match the design problems and the standard engineering conflicts stored. Associated with the inspiration of innovative thinking, the innovative operational model combined with hybrid and variation was proposed by the introduction of environmental features expand the design space [13]. LI proposed the intuitive thinking methods and used TRIZ principles and rules to standardize and guide the
direction of thinking [14]. The other inspirational method included models or systems of computer aided innovation design by the help of patent resources, such as triggering design inspiration by scenes [15].

Patent database collects inspiration achievement, and is increasing by millions patent applications per year. It has become a wealth of human inspiration. Therefore, the research of triggering design inspiration by biomimetic products patents can provide an effective and efficient method for product innovative design. Therefore, the acquisition of biomimetic product patents and recognition of trigger factors are key issues to be addressed.

**Methods of Stimulate Design Inspiration by Biomimetic Products Patents**

As biomimetic products patents and target products have the target function, so the target function can be used as an associate factor. By the help of acquiring the biomimetic product patents related to the objective function of the target products and using the principles and motion of biomimetic product patents to trigger the designer's inspiration, innovative design can be obtained. Therefore, acquiring the useful biomimetic product patents and identifying factors of triggering inspiration are two key problems.

**Acquiring the Biomimetic Product Patents Based on Semantic Associated Expansion**

The semantic associated expansion method contains some steps. First, the related objective function phrases are mined, then the needed expansive phrases of the objective function phrases are obtained, last the synonyms and near-synonyms phrases are found. Here, these phrases contained need to improve function are called the objective phrase, the function phrases contained in the summary are known as candidate phrases. Method of the semantic associated expansion to acquire the biomimetic product patents is showed as Figure 1.

![Figure 1. The method triggered design inspiration by biomimetic design knowledge.](image)

**Identifying Method of the Trigger Factor Based on the Inspiration Trigger Theory**

The trigger factor is closely related to the trigger object of the inspiration. The trigger objects of the inspiration can be concept with visual, hearing, touch, smell and taste. It usually exists in form of the scene or alternative scene, as video, pictures, text and audio. The trigger factors of the inspiration include the hided features of the objects, such as the work principle, shape, structure, function, behavior, movement, texture and color. In short, the trigger object of the inspiration is carrier of the trigger factor of the inspiration.

As the main vector of the trigger object of the inspiration, the text hides a large number of work principles, shape, structure, function, behavior, movement and other features. It is found that verbs, adjectives, and nouns are some factors that can trigger inspiration by studying the way of describing these characteristics. In which the effect of the specific verb, the transitive verb and noun modifiers becomes more apparent. However, the effect triggered inspiration by the word depends on the quality and validity of documents.

**Application Examples**

Diamond wire saw machine mainly can cut various shapes pipes relied on diamond wire for flexible and rigid diamond grains. Therefore, diamond wire saw machine must have a certain amount of tension to insure proper cutting jobs.

Current tensioning device of underwater diamond wire saw contain the manual tensioning device and the hydraulic tensioning device. The manual tensioning is simple, but tension adjustment is not
easy. The hydraulic tensioning device is long pressure and holding time and complex structure. Therefore, a new tensioning device is designed to remedy the existing shortcomings by some inspiration from the bio-patent. The process of biomimetic patented trigger design inspiration is the following described.

Acquire Biomimetic Product Patent

**Extract Candidate Phrases and Set Up with Synonyms and Related Libraries.** The objective function phrases are extracted from the summary of the target product patents, and a phrase base is set. According to their respective word meaning in context, the phrases are classified in order to get the expanded phrase variations. Purpose function of diamond wire saw machine is noise reduction, flexible, simplified design. By looking for synonyms and near-synonyms for semantic association expansion, expansion and variations words of the target phrases can be obtained.

**Search Biomimetic Product Patents.** Expansion words of the target phrase and words "Biomimetic" as a keyword, the biomimetic product patents is obtained by retrieving patent library. The biomimetic object includes jellyfish, fish, pangolins, and so on.

**Identify Inspiration Factor**

**Extract Protection Components.** The large of biomimetic patent is acquired through search patent library. Due to using of standardized terms, so, protection parts name can extracted through mode match method from patent literature.

**Access Sentences Contained Protected Parts.** The sentences contained protected parts can be obtained through two species way. One is recognizing protection parts, then containing long sentence. The other is using clues word in right requirements, then searching the long sentence contained structure, and property or behavior features related protection parts to extract features information triggered inspiration.

**Extract Feature Triggered Inspiration.** The feature triggered inspiration is some information relating to the protection of parts, structure, and property. They can be extracted via a regular expression from feature and name of the parts in the protection of the rights. They include geometric features and characteristics, and are mostly based on the verb, adjective or noun forms. The part of the bio-patent information is shown in Table 1.

<table>
<thead>
<tr>
<th>Ind ex</th>
<th>Patent number</th>
<th>Product name</th>
<th>Purpose function</th>
<th>Biomimetic object</th>
<th>Carrier</th>
<th>Trigger factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CN2015103</td>
<td>an underwater propulsion biomimetic device</td>
<td>To reduce the noise, flexible, simple structure</td>
<td>Bird</td>
<td>Swing arm</td>
<td>Reciprocating motion</td>
</tr>
<tr>
<td></td>
<td>82004.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CN2021751</td>
<td>an underwater biomimetic device</td>
<td>Flexible, simplified structure</td>
<td>Jellyfish</td>
<td>Linkage mechanism</td>
<td>Open closed</td>
</tr>
<tr>
<td></td>
<td>86U.</td>
<td></td>
<td></td>
<td>Fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CN2012103</td>
<td>an underwater biomimetic device</td>
<td>Flexible, simplified structure</td>
<td>Fish</td>
<td>Linkage mechanism</td>
<td>Swing</td>
</tr>
<tr>
<td></td>
<td>07229</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CN2015103</td>
<td>A new type of underwater biomimetic robot propulsion device Cassava harvesting machine biomimetic digging shovel</td>
<td>Flexible, simplified design</td>
<td>Fish</td>
<td>Permanent magnet</td>
<td>Swing</td>
</tr>
<tr>
<td></td>
<td>83391.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>CN2015103</td>
<td>Non-smooth surface shape design</td>
<td>Improve efficiency</td>
<td>Pangolin</td>
<td>Mobile</td>
<td></td>
</tr>
<tr>
<td></td>
<td>93649.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1. Biomimetic patent information**

**Acquire the Heuristic Knowledge**

A number of different implementations of variation of biomimetic product patents are searched through the function extension word, in which only those biomimetic product patents that have similar dynamic or static characteristics with targets product could inspire design inspiration. And the verbs, adjectives and nouns that are similar dynamic and static characteristics with targeted products need to be extracted. For example, the means function of the target product is "tightening"
and objective function is "simplified design", then the biomimetic product patents with "simplified structures" objective function has the potential to inspire new designs. In the tensioning device of diamond wire saw machine, the main motion to achieve "tight" function is reciprocating movement. Therefore, the different expressions and method of "reciprocating" are identified.

The work principles, such as effects of electro-magnetic, piezoelectric, carbon nanotubes, high temperature superconductivity, can be found. These are new ways of working principles for tensioning device of diamond wire saw machine. The new tensioning device designed by using magnetic principle is shown in Figure 2. The parts respectively is 1-handles, 2-anti-reseller, 3-end cover, 4-left bearing, 5-bearing, 6-sleeve, 7-drive axis, 8-drive disc, 9-magnet, 10-left document circle, 11-magnet, 12-fixed disc, 13-fixed axis, 14-right block circle, 15-right bearing, 16-tight axle, 17-tight round, 18-lock tight nut and19-bracket. This tensioning device has applied the national invention patent.

![Figure 2. Schematic diagram of tension device.](image)

**Conclusions**

A method of acquiring and analyzing the biomimetic product patents is presented to stimulate inspiration in the paper. This method can mine hidden association knowledge in patent documents, analyze inspirations stimulating factors in the biomimetic product patents according to the principle triggered inspiration, expand designers thinking and promote innovative solutions. The example shows that the method is effective, especially for less experienced design staff. The synonym database is needed to be expanded in the method. Next work is supplementing synonymy database focused on different product, so that it can better trigger design inspiration.

**References**


